EMERGING TRENDS IN AUTOMOTIVE ACTIVE-SAFETY APPLICATIONS

Purnendu Sinha, Ph.D.
Global General Motors R&D
India Science Lab, GM Tech Center (India)
Bangalore
OUTLINE OF THE TALK

- Introduction
- Landscape of Safety Features
- Recent Trends
  - Electronics, Software
  - System Architectures
  - System Integration
- Research Challenges
- Conclusion
ACTIVE SAFETY AND DRIVER ASSISTANCE SYSTEMS

- **Goals**
  - Enhance **safety** of vehicle and occupants during various driving maneuvers; avoid crashes
  - Enhance **convenience** of driver of the vehicle

- **Examples**
  - Forward collision warning
  - Adaptive Cruise Control
  - Curve speed control
  - Side blind zone alert
  - Lane change assist
  - Lane keeping / lane centering control
  - Cross traffic collision avoidance
  - Parking assist
LANDSCAPING OF SAFETY FEATURES

Active: prevent crashes from happening in the first place (proactive)

- ACC Stop & Go
- Automatic Parking Assist
- Lane Keeping Assistance
- ACC

Passive: mitigate the severity of a crash that is imminent (reactive)

- Collision Avoidance
- Automatic Braking
- Automatic Lateral Control
- Side Blind Zone Alert
- Crash Preparation
- Pedestrian Detection
- Pre-Crash Warning

Comfort

Safety
SAFETY SYSTEM EVOLUTION 1995-2025

Inter-section support, Urban Driving Assistance, Rural Driving Assistance

- Integrated Lane Change Assistance / Lane keeping System
- Longitudinal and Lateral Collision Avoidance systems
- Intelligent Speed

- Driver Drowsiness Warning
- Integrated Lane Change Assistance / Lane keeping System Curve speed warning

- Integrated Chassis System

- Pre-Crash Occupant Protection
- Active Pedestrian protection systems
- Crash Compatibility across Brands and Body Styles

- Passive Pedestrian protection systems
- Intra-brand Crash Compatibility
- Advanced Automatic Crash Notification

- Front air bag
- Side air bag
- Seat belt
- Seat belt warning

- ACC
- ACC (Stop & Go)

- Lane Departure Warning (LDW)
- Tire Pressure Monitoring Systems (TPMS)
- Blind Spot Detection (BSD)

- EBS / ABS
- ESP
- Emergency Brake Assist (EBA)
- Active Steering

- Occupant Detection and classification
  - Anti Submarining and variable stage deployment airbag
  - Whiplash protection
  - Belt pretensioning

- Pre-Crash Occupant Protection

- Advanced Automatic Crash Notification

Collision Avoidance
Driver Warning and Information Systems
Vehicle Stability Systems
Occupant Protection Safety Systems
Partner Protection
Automatic Notification System

Integration of DAS Applications with MAP Data

Source: Frost & Sullivan
360° Safety with Integrated Sensor Strategy

- Forward Vision System
  - Lane tracking
  - Object detection
  - Far IR capability

- Rear Vision System
  - Object detection
  - Far IR capability

- Enhanced Digital Map System

- Short-Range Blind-Spot Sensors

- Short-Range Sensors

- Long-Range Sensors

- Long-Range Scanning Sensor
**Key Dimensions – Systems, Sensors, HMI**

**Driver Assist Systems**
- **Adaptive Cruise Control (ACC)**
  - Radar 76/77 (1998)
  - Automatic braking and acceleration.
- **Intelligent Park Assist**
  - CMOS
- **Night Vision System (NVS)**
  - CMOS based Near Infrared Sensors
  - Far Infrared Sensors
- **Lane Departure Warning (LDW)**
  - Push Button
  - Haptic
- **Blind Spot Detection**
  - Radar 24 GHz > 79 GHz
  - CMOS
  - Push Button
  - Warning Light and Audible
  - Push Button
  - Visual Display
- **Collision Warning (CW)**
  - CMOS
  - Radar 24 GHz > 79 GHz
  - Automatic
  - Audible and Visual

**Driver Warning and Information Systems**
- **Source: Frost & Sullivan**

**Input Options**
- **Output Options**
- **Driver Assistance System**
- **Sensors Used**

2004 2010 2015
COLLISION AVOIDANCE SYSTEM - ARCHITECTURE

Source: Jurgen Leohold
PERSPECTIVES ON ACTIVE SAFETY FEATURE IMPLEMENTATION

Applications (Algorithms, SW)

Vehicle Integration (Architecture)

Active Safety

Driver Interface (HMI)

Components (Sensors, Actuators)
# Lane Departure Warning - Example

<table>
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<tr>
<th>Components</th>
<th>Algorithms</th>
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| ■ CMOS sensors (e.g., camera)  
■ Image processing ECU  
■ Electronic steering actuator for steering wheel vibration | ■ Lane recognition based on lane-markings  
■ Consideration of curves  
■ Monitoring of vehicle dynamics and driver actions |

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<th>Vehicle Integration</th>
<th>Driver Interface</th>
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| ■ HW integration  
■ Serial communication bus interfaces  
■ Sensor fusion | ■ Vibration warning via steering wheel  
■ System warning strategy  
■ System status via icons in instrument panel |

Image Source: http://images.businessweek.com/ss/06/09/cartech/source/4.htm
CHALLENGES WITH ACTIVE SAFETY SYSTEMS

- 360° sensing via vision, radar, infrared, sonar
- Sensor fusion for higher level situational awareness
- **Robustness**: how should the vehicle behave in anticipation of every possible real-world driving scenario, in the presence of variability in:
  - Driver experience, skill level, and mental state (e.g., age, drowsiness, inattentiveness, impairment)
  - Vehicle state of health / maintenance / repair
  - External environmental factors (weather conditions, road conditions, traffic conditions)
CONCLUSION

- There is a lot of activities going on in this space…

- Future “sensor-dependent” systems will be the key differentiator in active and passive safety features.

- Consumers are becoming increasingly comfortable with “driver-aids” and demand more relief from the tedium of driving.

- Active safety, by-wire technologies, cooperative driving, drive-train powered by electric motors, etc. – will help us inch towards “autonomous driving”
Thank You